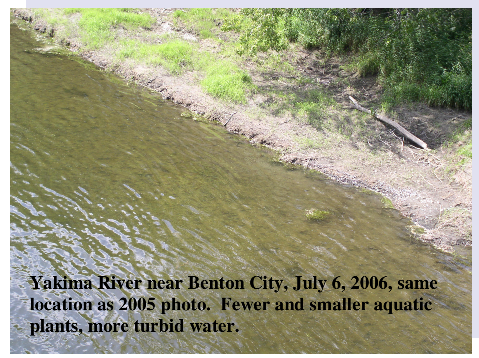
Turbidity

Near Benton City, downstream of roughly 368,000 acres of intensively irrigated cropland, the median turbidity from April 20 to September 30, 2005 was 1 Formazin Nephelometric Unit — almost crystal clear. This astonishingly low value was likely due to a combination of the filtering and slowing effect of the abundant water star-grass, very little spring runoff due to a drought, and decreased turbidity in return flows from irrigated cropland. In 2006, the median turbidity during the same months increased to 6 Formazin Nephelometric Units, due to in part to increased turbidity during spring snowmelt, increased turbidity in at least two major irrigation return drains, and reduced water star-grass abundance.

Yakima River near Benton City, June 7, 2005. Photo taken from a bridge. Turbidity was at or near zero (crystal clear) from late May to August 2005. The river was roughly 7 feet deep in the lower left-hand corner of this photo.



Yakima River near Benton City, July 6, 2006, same location as 2005 photo. Fewer and smaller aquatic plants, more turbid water.

Future Management Considerations

South Yakima and Benton conservation districts were involved in this study to learn what could be done to improve conditions in the river. What take-home lessons did we learn? What can be done to reduce excessive plant growth and its adverse effects on the river? Of the factors examined which could potentially limit plant growth, only light availability and substrate stability appeared to explain differences in plant abundance. Yet it is not possible to artificially create ample spring runoff resulting in turbid, deep and high-velocity conditions in a water-short year. It is also not possible to change the underlying reasons for the stability of the substrate in much of the Kiona reach — the substrate size and the river being constrained by bedrock. What about reducing nutrients? Heavily-rooted aquatic plants, such as water star-grass, are able to obtain nutrients from either the water or the river bed. Since there are abundant nutrients in the river bed, attempts to reduce nutrients in the river water would likely have no effect on plant abundance. In short, what we learned from this study has already been valuable by showing us what *not* to do. But it has not yet led us to "the answer" of how to manage excessive plant growth in this river. It may become necessary to manage the plants directly instead of attempting to change their habitat.

Conclusions

Differences in aquatic plant abundance throughout the lower 116 miles of the Yakima River could be explained, in part, by differences in substrate stability: plants were highly abundant only in the bedrock-confined reaches of the river with stable substrate. Differences in plant abundance in the lower 43 miles of the river over recent years could be explained, in part, by differences in water clarity and flow. Decreased erosion from irrigated cropland in the late 1990's improved water clarity and thus light penetration in the river. Additionally, frequent below-average snowpacks from 2000 through 2005 resulted in shorter or less intense spring runoff events. Plant abundance peaked in 2005, then decreased significantly in 2006 and 2007 due to prolonged turbid, deep, fast spring runoff. Dissolved oxygen and pH conditions improved in 2006 and 2007 but did not meet regulatory standards.

Four years of continuous monitoring under widely different flow conditions allowed us to directly observe the effect of changing habitat conditions (e.g., turbidity, velocity, depth) on plant abundance. But none of the observed differences suggested a viable management strategy during future water-short years if excessive plant growth should return.

This handout is one of a series of five handouts on different topics relating to nutrient-enrichment processes in the lower Yakima River. For more information, contact the South Yakima Conservation District at (509) 837-7911.

Draft ver2

Water Star-Grass in the Lower Yakima River

South Yakima
Conservation District

April 2008

Benton
Conservation District

The U.S. Geological Survey, South Yakima Conservation District, and Benton Conservation District worked together to study the lower 116 miles of the Yakima River from 2004 through 2007 to learn more about nutrients, algae, rooted aquatic plants, and dissolved oxygen and pH conditions in the river. One key purpose of the study was to try to discover why a native aquatic plant, Heteranthera dubia, *called water star-grass, had recently become much more abundant. Why the concern? Excessive algal and plant growth in rivers may result in insufficient dissolved oxygen due to plant respiration and high pH levels due to photosynthesis. Was this occurring in the Yakima River?*

The opinions and conclusions expressed in this flyer are those of the conservation districts, not the U.S. Geological Survey. The final project report from USGS is not yet completed. This information is being provided before the final report because of timing constraints from the grant funding which paid for this work.

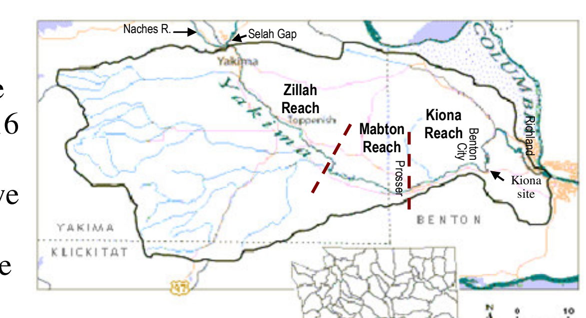
Introduction

Water star-grass in the lower Yakima River near Benton City, July 2005

Water star-grass is a native aquatic plant, once of concern in Washington State due to its limited numbers. It is frequently found throughout the U.S. but usually as a small component of the aquatic plant community. In some places it has been planted in streams to restore native plant communities. The only dense growth of water star-grass the Department of Ecology's aquatic plant specialist had observed throughout the 1990's was in gravel pits near the City of Yakima.

In 2002, people started noticing an increasing abundance of plants in the river. Scientists familiar with the Yakima River were concerned that excessive plant growth could worsen its water quality. In 2004, the Department of Ecology awarded a grant to South Yakima Conservation District to work cooperatively with the U.S. Geological Survey and Benton Conservation District to find out what was happening. By 2005, the plants were channel-spanning for more than thirty miles downstream of Benton City. Then, in 2006 and 2007, plant growth declined substantially. Why these sudden and dramatic changes?

Differing Plant Abundance Within the River

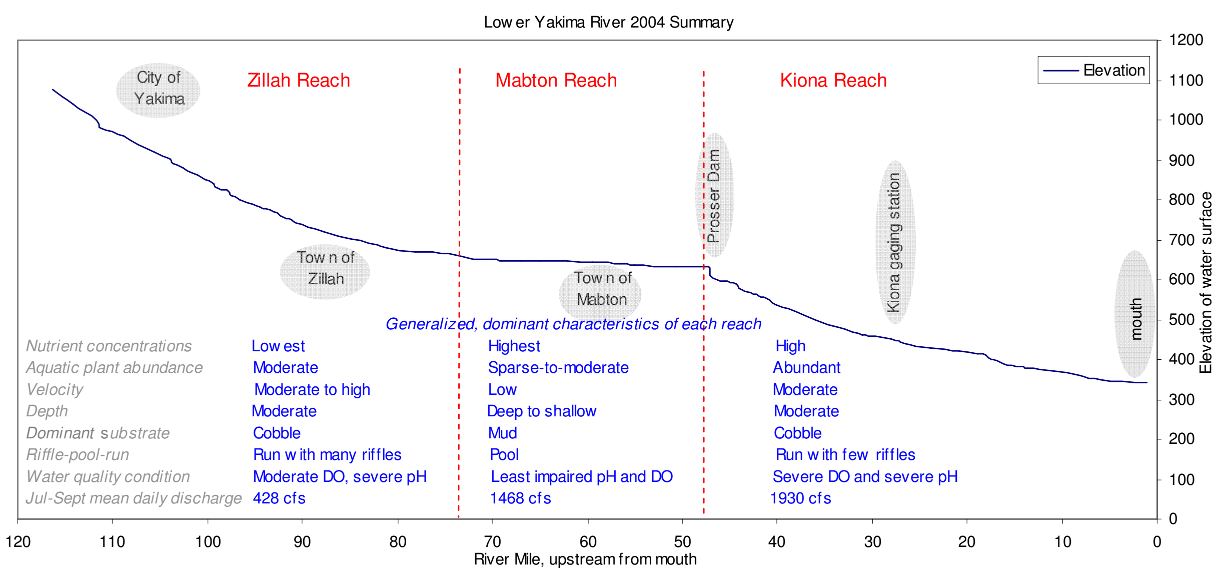


To begin to understand what was happening, first we had to explore the entire lower 116 miles of the river. We focused on the lower 116 miles because the upper 98 miles differed significantly in gradient, geology, climate and human impact. Within the lower 116 miles, we needed to learn: (1) where aquatic plants were most and least abundant, (2) which plant species were present, and (3) if there were physical characteristics of the river which might explain the differences. In 2004, we found:

Continued on next page...

2004 major findings:

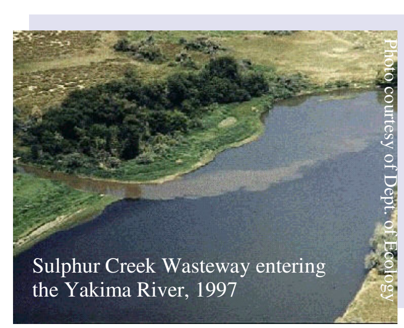
- Rooted aquatic plants were most abundant from roughly three miles below Prosser Dam to West Richland. While dense plant beds occurred elsewhere, they covered less of the cross-section and fewer continuous miles.
- The dominant species downstream of Prosser was water star-grass. The species present upstream of Prosser were more diverse, including curly leaf pondweed, sago pondweed, coontail, and *Elodea*.
- Based on morphology, aquatic growth, and water quality, the lower 116 miles of the river could be broken into three functionally different segments: the Zillah, Mabton, and Kiona reaches. The differences in plant abundance did not correspond to any single characteristic of the river for which we obtained data in 2004 including substrate type, velocity, depth, or turbidity. However, substrate stability may help explain differences in plant abundance. The substrate moves much more frequently in the Zillah reach than in the Kiona reach. The aquatic plants in the Zillah reach don't have a stable base on which to grow year after year. In contrast, in much of the Kiona reach, the river is constrained by bedrock, so the cobble substrate is likely disturbed only in the most extreme floods.



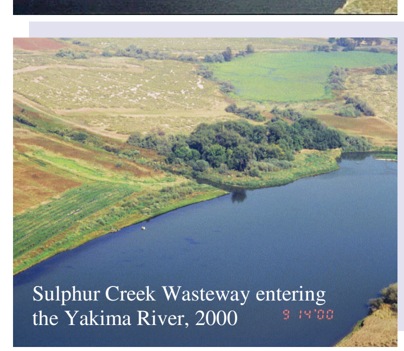
Differing Plant Abundance Over Recent Years

Why did water star-grass become highly abundant in 2004 and 2005? At least two conditions changed over recent years in the Yakima River — turbidity (a measure of water clarity) and flow.

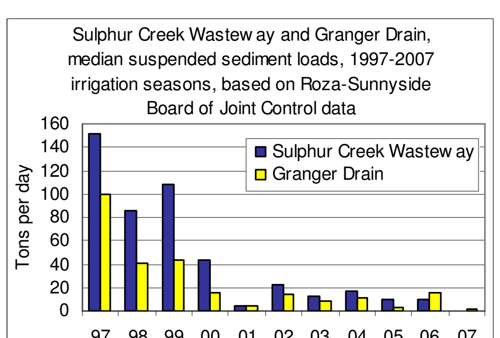
Turbidity. Improved irrigation practices by growers in the lower Yakima Valley resulted in decreased erosion, so less suspended sediment entered the Yakima River and turbidity decreased. Increased water clarity allowed sunlight to penetrate deeper in the water column, encouraging aquatic plant growth.

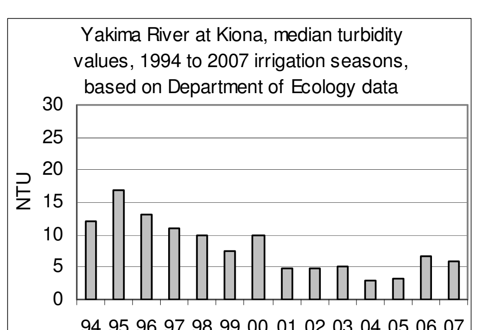


Sulphur Creek Wasteway entering the Yakima River, 1997

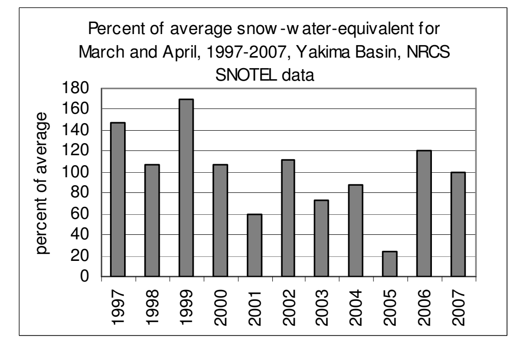


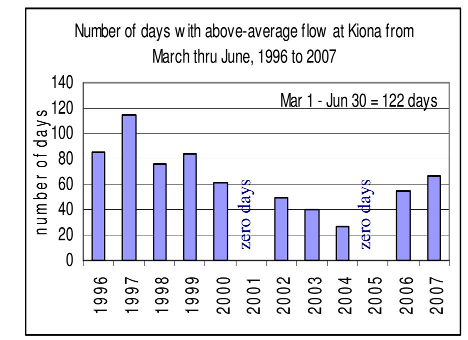
Sulphur Creek Wasteway entering the Yakima River, 2000

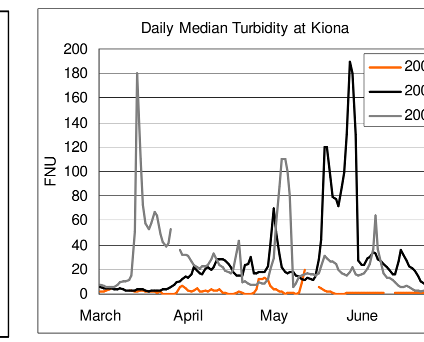




Snowpack and Spring-time Flows. From 2000 to 2005, four out of six years had below-average snowpack, including droughts in 2001 and 2005. The number of days with above-average springtime flows in the Yakima River declined from 1997 through 2005. Then, in 2006, above-average snowpack in the Cascade Mountains increased spring run-off. As a result, the river was generally turbid, fast, and deep for the first four months of the growth period for water star grass — adverse conditions for aquatic plant growth. Photosynthetically-active solar radiation measured in the river showed there frequently was not enough light reaching the river bottom to allow plant growth during the spring. The result? In 2005, the median (typical) biomass (dry weight of plant material) in a 2-mile section of the river was 1,020 grams per square meter. In 2006, in the same 2-mile section, the median biomass was 32 grams per square meter, a decrease of 97 percent. In 2007, the spring run-off from an average snowpack again resulted in prolonged turbid, deep, fast conditions in the river. The run-off ended sooner in 2007 than 2006, allowing for a slightly longer growing season for the plants. Biomass increased slightly to 84 g/m2.







Effects of Differing Plant Abundance on the River

The amount of water star-grass affected the hydrology and water quality of the river.

Hydrology. In the fall of 2001, there were enough aquatic plants in the river to affect its depth and velocity — but only slightly. By 2005, however, the water star-grass was so abundant the sheer mass of plant material caused a significant damming effect in the lower river. The river was three feet deeper and one foot-per-second slower *at the same volume of water* than it was before the excessive plant growth. Then, in 2006 and 2007, the abundance of water star-grass declined substantially and the damming effect decreased.

Water Quality. Near Benton City, a water quality monitor in the river obtained data nearly every 15 minutes from April 2004 through September 2007, allowing for powerful comparisons between years. In the summers of 2004 and 2005, dissolved oxygen and pH conditions were frequently poor. Dissolved oxygen concentrations near dawn were as low as 3 milligrams per liter (mg/L) on several days — near lethal for sensitive fish species such as salmonids. In late afternoons, high pH values — often above 9.2 — were also of concern.

But in 2006 and 2007, conditions improved. Fewer days had extremely low dissolved oxygen concentrations or high pH values. Fewer plants meant decreased respiration and photosynthesis from the plants. Plus there was less habitat for algae to grow on, so there was also less respiration and photosynthesis from algae. Fewer plants also meant fewer bacteria decomposing plant material, decreasing another source of respiration. Despite the improved conditions, the state standards — at least 8 mg/L dissolved oxygen and no more than a pH of 8.5 — were not met.